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ESTIMATED OIL AND GAS RESERVES GULF OF MEXICO OUTER CONTINENTAL SHELF AND CONTINENTAL SLOPE

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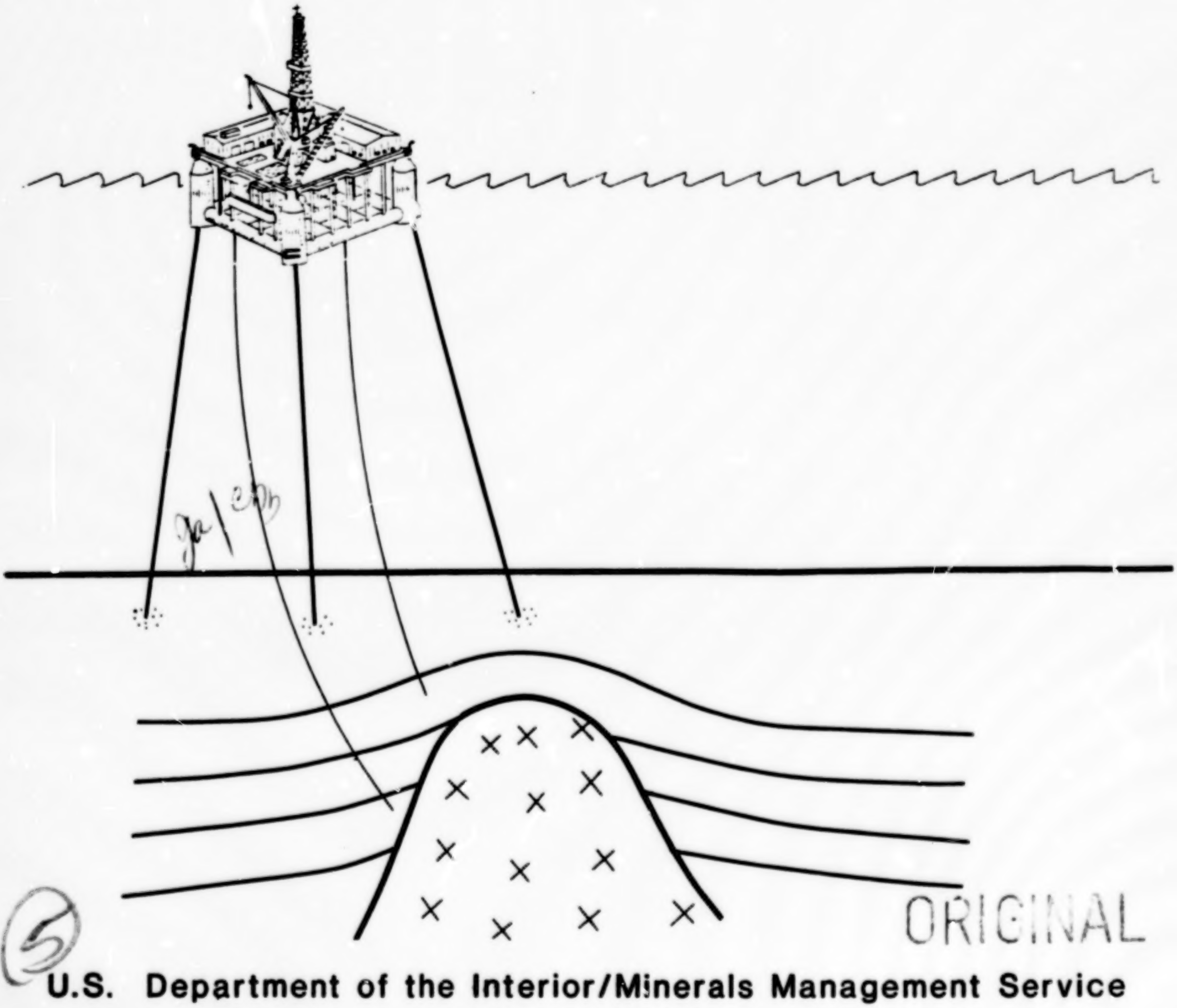
December 31, 1983



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U.S. Department of the Interior/Minerals Management Service

ESTIMATED
OIL AND GAS RESERVES
GULF OF MEXICO
OUTER CONTINENTAL SHELF
AND CONTINENTAL SLOPE

December 31, 1983

Prepared by

MINERALS MANAGEMENT SERVICE
GULF OF MEXICO OCS REGION

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Estimated Oil and Gas Reserves
Gulf of Mexico Outer Continental Shelf and Continental Slope
December 31, 1983

By Jack E. Hewitt, Jeff P. Brooke,
and John H. Knipmeyer

ABSTRACT

Remaining recoverable reserves of oil* and gas in the Gulf of Mexico Outer Continental Shelf and Continental Slope have been estimated to be about 3.41 billion barrels of oil and 43.7 trillion cubic feet of gas, as of December 31, 1983. These reserves are recoverable from 505 studied fields under the Federal submerged lands off the coasts of Louisiana and Texas. An additional 51 fields, discovered since December 31, 1981, have not been sufficiently developed to permit a reasonably accurate estimate of reserves.

Original recoverable reserves are estimated to have been 9.31 billion barrels of oil and 106.2 trillion cubic feet of gas from 521 fields in the same geographic area. Included in this number are 16 fields that are depleted and were abandoned; not included are the 51 insufficiently developed fields. Estimates were made for individual reservoirs in 399 fields and on a fieldwide basis for the other 122 fields.

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*The term "oil" as used in this report includes crude oil and condensate.

INTRODUCTION

This report, which supersedes USGS Open-File Report 83-122 (Hewitt, Brooke, and Knipmeyer, 1983), presents estimates of original recoverable reserves, cumulative production, and estimates of remaining recoverable reserves as of December 31, 1983. The estimates of reserves for this report were completed in April 1984 and represent the combined efforts of engineers, geologists, paleontologists, and other personnel of the Minerals Management Service, Metairie, Louisiana.

As in previous reports (for example, Bryan and others, 1978), standard methods of estimating reserves were used, including volumetric calculations, decline curve analysis, material balance, and mathematical simulation.

DEFINITION OF RESERVE AND RESOURCE TERMS

The reserve and resource terminology in this report conforms with Dolton and others (1981, p. 6-7). The quoted definitions of terms applicable to this report are:

"Resources.--Concentrations of naturally occurring liquid or gaseous hydrocarbons in the Earth's crust, some part of which is currently or potentially economically extractable."

"Measured reserves.--That part of the economic identified resource that is estimated from geologic evidence supported directly by engineering measurements. Measured reserves here are equivalent to proved reserves as defined by API (1976, p. 1)."

"Indicated reserves.--Reserves equivalent to API indicated additional reserves, that are defined as economic reserves in 'known productive reservoirs in existing fields expected to respond to improved recovery techniques such as fluid injection where (a) an improved recovery technique has been installed but its effect cannot yet be fully evaluated; or (b) an improved technique has not been installed but knowledge of reservoir characteristics and the results of a known technique installed in a similar situation are available for use in the estimating procedure.' (API, 1976, p. 1, 2.)"

For this report other definitions used are:

Reserves.--That portion of the identified resource which can be economically extracted.

Demonstrated reserves.--A collective term for the sum of measured and indicated reserves.

Production data are the metered volumes of raw liquids and gas reported to Minerals Management Service by Federal lessees and operators. Oil volume measurements and reserves are corrected to reference standard conditions of 60° Fahrenheit and 14.696 psia (one atmosphere); gas measurements and reserves are corrected to 60°F and 15.025 psia. Continuously measured volumes from production platforms and/or leases are allocated to individual wells and reservoirs on the basis of periodic well test "gauges." This introduces approximations in both production and reserves data by reservoirs, limiting accuracy to two or three significant figures.

RESERVES AND RELATED DATA REPORTED BY AREA

On December 31, 1983, there were 556 active fields in the federally regulated part of the Gulf of Mexico as listed by the Minerals Management Service Gulf of Mexico Regional Field Names Committee. Of these, 505 were considered sufficiently developed to warrant estimation of reserves for this study. Another 51 were not sufficiently developed to permit a reasonably accurate estimate of reserves; therefore, no estimates have been attempted. In addition to the 505 active fields, 16 depleted fields (abandoned after production) are reported herein. This makes a total of 521 fields for which oil and gas reserves were estimated. The 16 depleted fields are not included in the Regional Field Names Committee's 556 active fields, but are reported here in order to give a complete record of cumulative oil and gas production. For any field contained partly in State waters and partly in Federal waters, reserves are estimated for the Federal portion only.

Reserve data and various classifications of fields, leases, boreholes, and completions are presented as area totals in tables 1 and 2. The areas are those used by the Minerals Management Service for administrative purposes (fig. 1). Estimates of demonstrated reserves for all producing fields as well as all fields discovered prior to December 31, 1981, are presented as area totals in table 1. The 521 fields studied (505 active fields and 16 depleted fields) constitute the current listing in the Minerals Management Service Outer Continental Shelf Information System (OCSIS). The 51 fields not sufficiently developed for study are not represented in the reserve data or in the OCSIS data processing system.

All Gulf of Mexico Outer Continental Shelf and Slope Federal leases as of December 31, 1983, are represented in table 2. The 3,117 active leases and 1,942 relinquished leases are each classified into two main groups, studied and not studied. Further subgrouping and definitions of the groups are shown below:

Studied Active.--Active leases designated within the 505 active studied fields presented in table 1.

Table 1.--Estimated demonstrated oil and gas reserves for 521 fields by area, Gulf of Mexico

Outer Continental Shelf and Slope, December 31, 1983

(Demonstrated reserves: the sum of measured and indicated reserves. Oil expressed in millions of barrels, gas in billions of cubic feet. "Oil" includes crude oil and condensate; "gas" includes associated and nonassociated gas. Remaining reserves estimated as of December 31, 1983.)

Area(s) (fig. 1)	Number of fields				Original recoverable reserves		Cumulative production through 1983		Remaining recoverable reserves	
	Studied		Not studied	Active with production						
	Active	Depleted			Oil	Gas	Oil	Gas	Oil	Gas
Mustang Island and Padre Island....	12	0	0	6	5	670	0	100	5	570
Matagorda Island..................	9	0	5	5	4	790	1	140	3	650
Brazos............................	13	2	3	11	7	1,200	3	500	4	700
Galveston.........................	8	0	3	8	27	900	21	700	6	200
High Island.......................	65	0	3	55	240	9,000	60	3,800	180	5,200
West Cameron and Sabine Pass.......	69	2	8	62	200	16,400	80	9,500	120	6,900
East Cameron.......................	35	3	2	35	200	7,600	120	5,200	80	2,400
Vermilion..........................	54	3	2	48	460	12,700	240	8,500	220	4,200
South Marsh Island.................	37	1	0	36	720	11,700	370	6,800	350	4,900
Eugene Island......................	52	1	3	47	1,300	13,700	800	8,600	500	5,100
Ship Shoal.........................	39	1	6	35	1,040	9,700	700	6,200	340	3,500
South Timbalier and Bay Marchand...	23	1	3	19	1,200	5,500	900	3,300	300	2,200
South Pelto........................	6	0	2	5	110	600	65	300	45	300
Grand Isle.........................	14	0	1	11	880	3,700	680	2,600	200	1,100
West Delta.........................	16	0	2	16	1,080	4,500	900	2,900	180	1,600
South Pass.........................	10	0	1	8	760	2,200	460	1,200	300	1,000
Main Pass, Breton Sound, and Chandeleur Area..................	27	2	4	23	760	3,400	440	2,000	320	1,400
Continental Slope* and MAFLA**.....	16	0	3	4	320	1,950	60	150	260	1,800
Subtotal.......	505	16								
Total.....................	521		51	434	9,313	106,210	5,900	62,490	3,413	43,720

*Continental Slope includes the following areas: Corpus Christi, East Breaks, Garden Banks, Green Canyon, Ewing Bank, Mississippi Canyon, and Viosca Knoll.

**MAFLA includes the areas off the Mississippi, Alabama, and Florida coasts.

Table 2.--Status of leases, boreholes, and completions by area, Gulf of Mexico Outer Continental Shelf and Slope, December 31, 1983

Area(s)	Number of leases studied		Number of leases not studied			Number of boreholes		Number of active completions
	Active	Abandoned	Producible	Exploratory	Expired	Drilled	Abandoned	
Mustang Island and Padre Island....	19	0	1	137	99	190	120	56
Matagorda Island..................	25	0	5	56	19	207	75	76
Brazos............................	23	2	3	53	63	248	127	94
Galveston.........................	21	1	3	72	210	292	174	131
High Island.......................	143	7	6	161	198	1,561	683	870
West Cameron and Sabine Pass.......	202	22	7	159	159	1,901	838	1,168
East Cameron......................	90	11	2	55	156	1,208	576	678
Vermilion.........................	141	12	2	82	137	1,665	748	1,001
South Marsh Island................	103	13	0	32	61	1,642	643	1,089
Eugene Island.....................	166	27	6	76	109	2,772	1,145	1,821
Ship Shoal........................	118	13	5	76	106	2,137	804	1,621
South Timbalier and Bay Marchand...	89	6	3	77	109	1,704	558	1,720
South Pelto.......................	15	0	2	2	9	219	97	154
Grand Isle........................	56	4	1	14	38	910	421	887
West Delta........................	65	10	2	32	61	1,906	812	1,376
South Pass........................	47	2	1	5	21	1,173	430	924
Main Pass, Breton Sound, and Chandeleur Area..................	89	8	4	83	97	1,335	488	1,120
Continental Slope*................	39	0	3	344	55	411	224	137
MAFLA**...........................	0	0	1	93	97	30	29	0
Total.....................	1,451	138	57	1,609	1,804	21,511	8,992	14,923

*Continental Slope includes the following areas: Corpus Christi, East Breaks, Garden Banks, Green Canyon, Ewing Bank, Mississippi Canyon, and Viosca Knoll.

**MAFLA includes the areas off the Mississippi, Alabama, and Florida coasts.

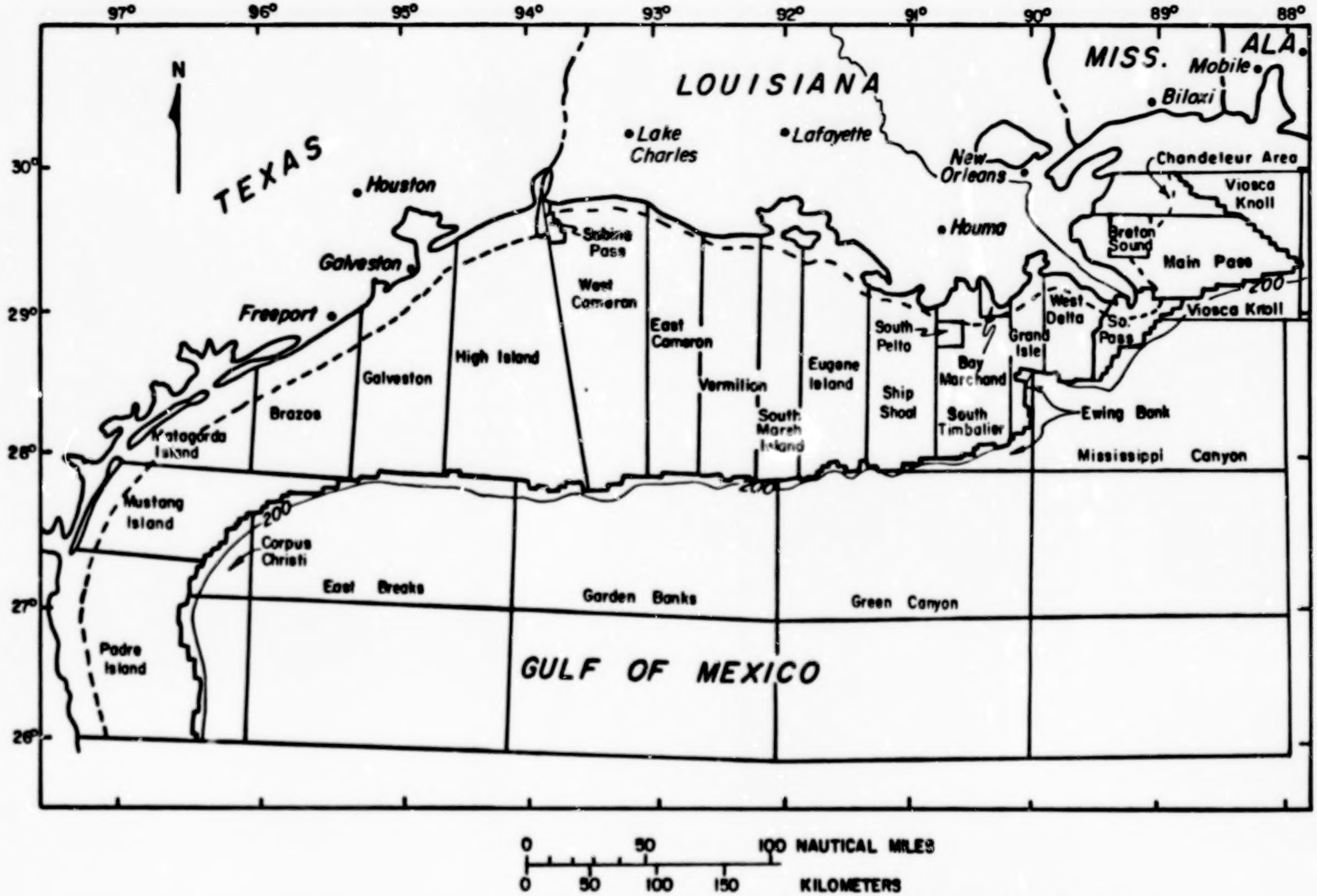

Figure 1.--Index map showing Outer Continental Shelf and Slope leasing areas off Texas and Louisiana. Dashed lines, shown at 9 nautical miles (3 marine leagues) from the Texas coast and 3 nautical miles from the Louisiana coast, indicate boundary between State and Federal waters. Solid line indicates 200-meter water depth.

Studied Abandoned.--Leases relinquished after oil or gas production. The leases associated with the 16 depleted fields are represented here along with other relinquished leases that were once part of fields still active.

Not Studied Producible.--Leases associated with the 51 fields insufficiently developed for study. The leases have qualified as producible under OCS Order No. 4, Determination of Well Producibility, but have not established continuous production.

Not Studied Exploratory.--Active leases not yet qualified as producible or associated with any field.

Not Studied Expired.--Leases relinquished by the operator without ever having produced any oil or gas even though some were once qualified producible under OCS Order No. 4, Determination of Well Producibility.

Also shown in table 2 are the total number of boreholes drilled and the number of those boreholes that have been plugged and abandoned in accordance with OCS Order No. 3, Plugging and Abandonment of Wells. The last column of table 2 presents the total number of active completions per area. Active completions are defined as those with perforations open to the formation and not isolated by permanent plugs. The presence or absence of production or injection is not considered.

The reserves and production data of the 505 active fields and the 16 depleted fields have been classified by geologic age and are presented in table 3. Age determinations were made by paleontologic examination of borehole cuttings where feasible. In areas with limited paleontological information, geologic ages were extrapolated from adjacent blocks with biostratigraphic control. The generalized locations of the three major trends are

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Table 3.--Estimated demonstrated oil and gas reserves for 521 fields by geologic age, Gulf of Mexico Outer Continental Shelf and Slope, December 31, 1983

(Demonstrated reserves: the sum of measured and indicated reserves. Oil expressed in millions of barrels, gas in billions of cubic feet. "Oil" includes crude oil and condensate; "gas" includes associated and nonassociated gas. Remaining reserves estimated as of December 31, 1983.)

Geologic Age	Original Recoverable Reserves		Cumulative Production through 1983		Remaining Recoverable Reserves	
	Oil	Gas	Oil	Gas	Oil	Gas
Pleistocene..............	3,300	44,660	1,690	24,200	1,610	20,460
Pliocene.................	2,750	15,980	1,890	9,940	860	6,040
Upper Miocene............	2,680	21,560	1,950	13,650	730	7,910
Middle Miocene...........	505	19,370	335	12,610	170	6,760
Lower Miocene............	73	3,870	33	1,760	40	2,110
Oligocene................	5	740	2	320	3	420
Unclassified.............	0	30	0	10	0	20
Total.............	9,313	106,210	5,900	62,490	3,413	43,720

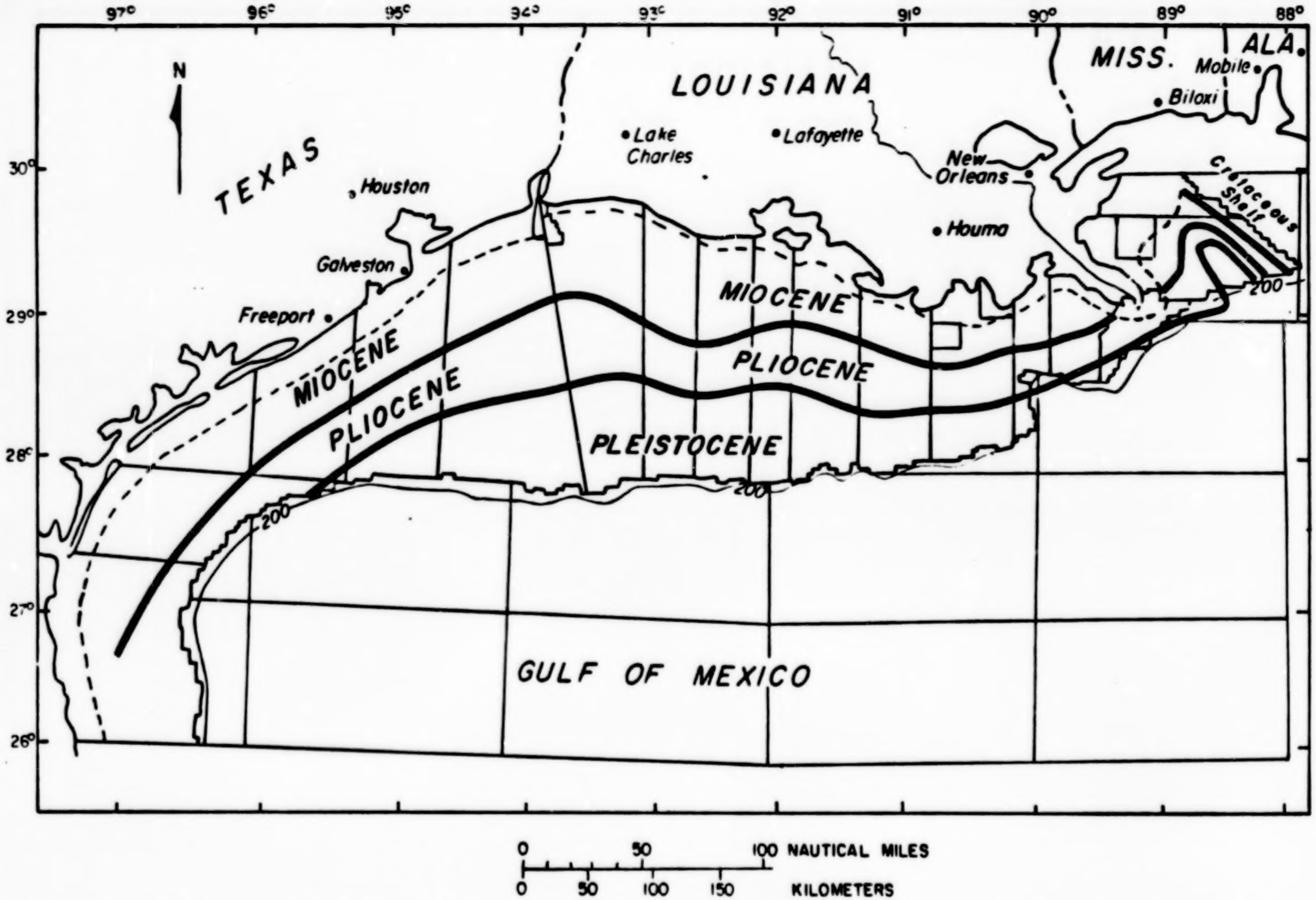

Figure 2.- - Index map showing Major Production Trends by Geologic Age of the Outer Continental Shelf and Slope leasing areas off Texas and Louisiana. Dashed line indicates boundary between State and Federal waters. Solid lines indicate the general boundaries between trends. Trend lines terminate on the basis of known reserves. No downdip limit for Pleistocene reserves is indicated.

shown in figure 2. Overlapping of adjacent trends occurs to varying degrees but has not been presented. Although Oligocene production is shown in table 3, it is not a major trend; therefore, it is not shown in figure 2.

STUDIES CONDUCTED

Estimates for 399 of the 521 fields are based on studies of approximately 15,100 individual reservoirs. A volumetric estimate was made for each reservoir and, for many of the reservoirs, at least one other estimation method (for example, decline curve analysis) was used. The subsequent performances of the reservoirs are periodically compared to the original predictions, and revisions to these predictions are made as needed. Reserve estimates for the remaining 122 fields in the OCSIS system were made on a fieldwide basis from production studies or, for nonproducing fields, from volumetric estimates.

Each abandoned field that had production has been assigned a value for original recoverable hydrocarbons equal to the amount actually produced.

FIELD-SIZE DISTRIBUTION

The distribution of the various sizes of recoverable field reserves is shown in figures 3, 4, and 5. Figure 3 shows the field-size distribution of the original recoverable oil reserves for the 113 fields primarily producing oil, and figure 4 shows the field-size distribution of original recoverable gas reserves for the 408 fields primarily producing gas. Figure 5 shows the field-size distribution of the total original recoverable hydrocarbon reserves for the 521 fields included in this report. A geometric progression was selected for the horizontal scales in consideration of the log-normal type of distribution.

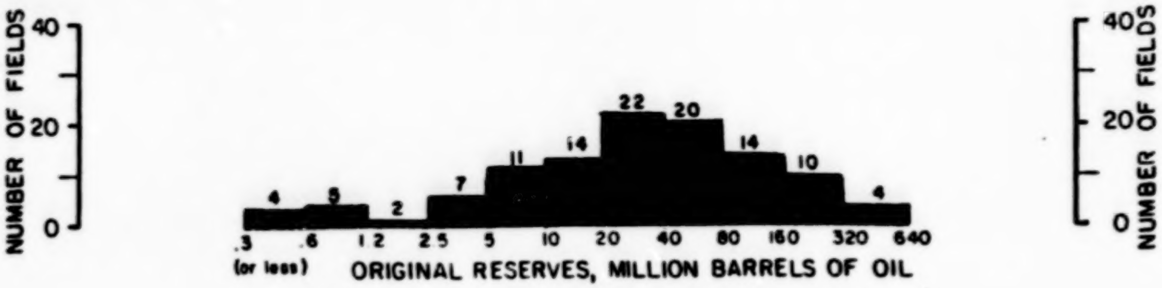

Figure 3. Field-size distribution
113 Oil Fields

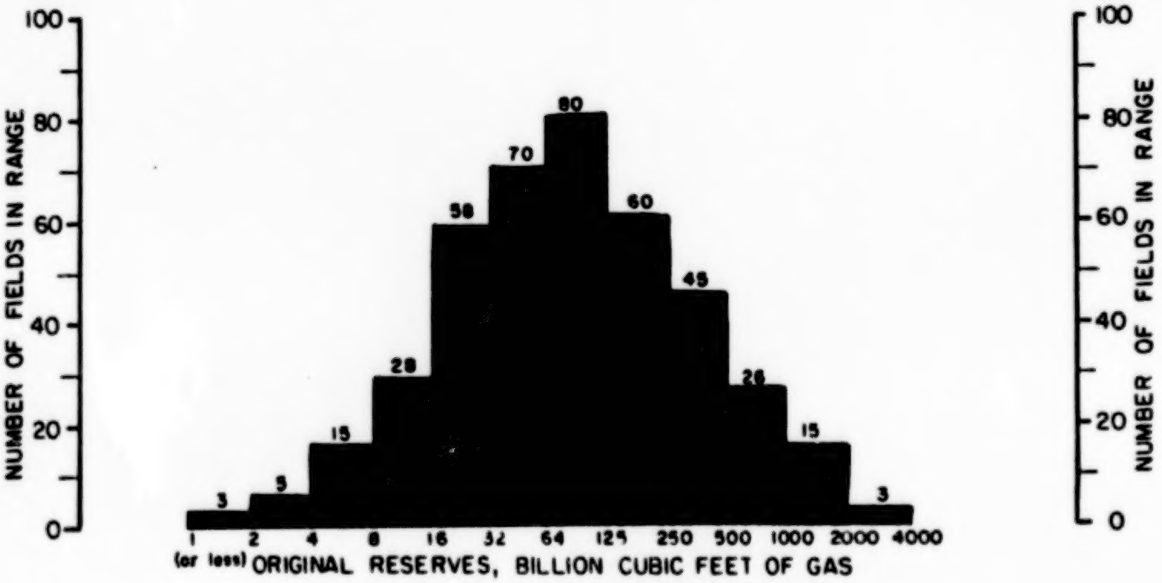

Figure 4. Field-size distribution
408 Gas Fields

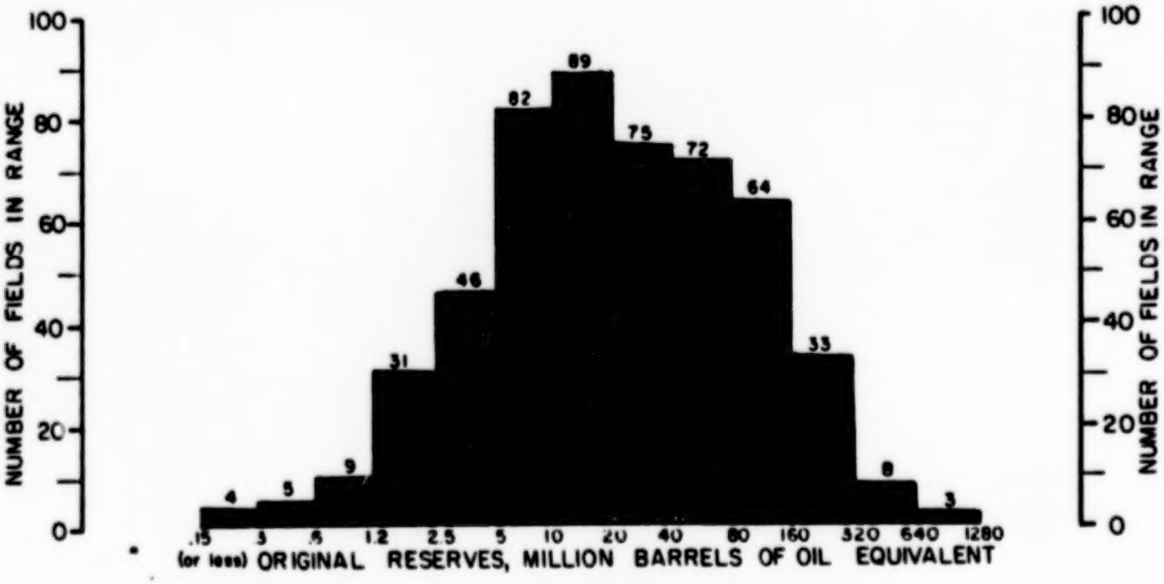

Figure 5. Field-size distribution
521 Fields

Figure 3 illustrates that the median (exceeded by 50 percent of the fields) is 31 million barrels of oil and the mean (weighted average) is 66 million barrels of oil. The petroleum industry commonly rates oil fields having original recoverable reserves of 100 million barrels or more as "major oil fields." Of the oil fields considered in this report, 22 contained 100 million barrels or more, accounting for 63 percent of the total original recoverable reserves contained in the 113 fields. Among the 408 gas fields (fig. 4), the median is 82 billion cubic feet of gas and the mean is 205 billion cubic feet of gas. The largest 40 gas fields contained 51 percent of the total recoverable gas reserves.

Figure 5 shows, combined, the field-size distribution of the original recoverable hydrocarbon reserves of the 521 fields. For convenience of comparison gas reserves are expressed in terms of barrels of oil equivalent (BOE) and added to the liquid reserves expressed in barrels. Based on the heating values of average Gulf of Mexico OCS hydrocarbons, a conversion factor of 5,400 standard cubic feet of gas equals one BOE was utilized. The median field reserve is 20 million BOE and the mean is 55 million BOE. Ten percent of the fields (the largest 52 fields) contained 50 percent of the total recoverable hydrocarbon reserves.

DISCOVERY AND PRODUCTION TRENDS

Figures 6 through 9 show oil and gas reserves and production data classified by discovery date. The year of discovery assigned to a field is the year in which the first well encountering significant hydrocarbons in that field was drilled. This date may differ from the year in which the field discovery was announced. The total field reserves, as currently estimated, are allocated to the year of discovery and combined for plotting. As a field develops, the total field reserves as originally estimated may subsequently change. This will be reflected by new totals at the field's discovery date. The annual discovery curves have been replotted to reflect new discoveries and annual revisions terminating with fields discovered prior to December 31, 1981. Data for 1980, 1981, and 1982 are presented, but are probably too recent to permit a lasting assessment of the reserves discovered in those years. Only those 1982 discoveries which have initiated production of oil or gas have been included.

Figures 6 and 7 present, respectively, oil and gas reserves discovered, cumulative production, and reserves remaining as of December 31, 1983, summed according to the year of field discovery. The degree of field depletion may be estimated by the relative positions of the cumulative production curves and the reserves remaining curves. For example, if the value of the remaining reserves is higher than the value of cumulative production for a given year, the aggregate depletion rate for fields discovered that year is less than 50 percent. The plots demonstrate that oil fields discovered after 1972 and gas fields discovered after 1973 are less than 50 percent depleted.

Figures 8 and 9 show annual discoveries and annual production. Superimposed on each plot of yearly discoveries is a line depicting the 7-year moving average, which better indicates the overall trend by smoothing out the peaks. The average presented is the total of the hydrocarbons discovered in a 7-year period divided by seven and plotted for each middle year. For comparison with the rate of discoveries, the annual production of oil and gas is also shown. The annual oil production (fig. 8) has exceeded the 7-year moving average of

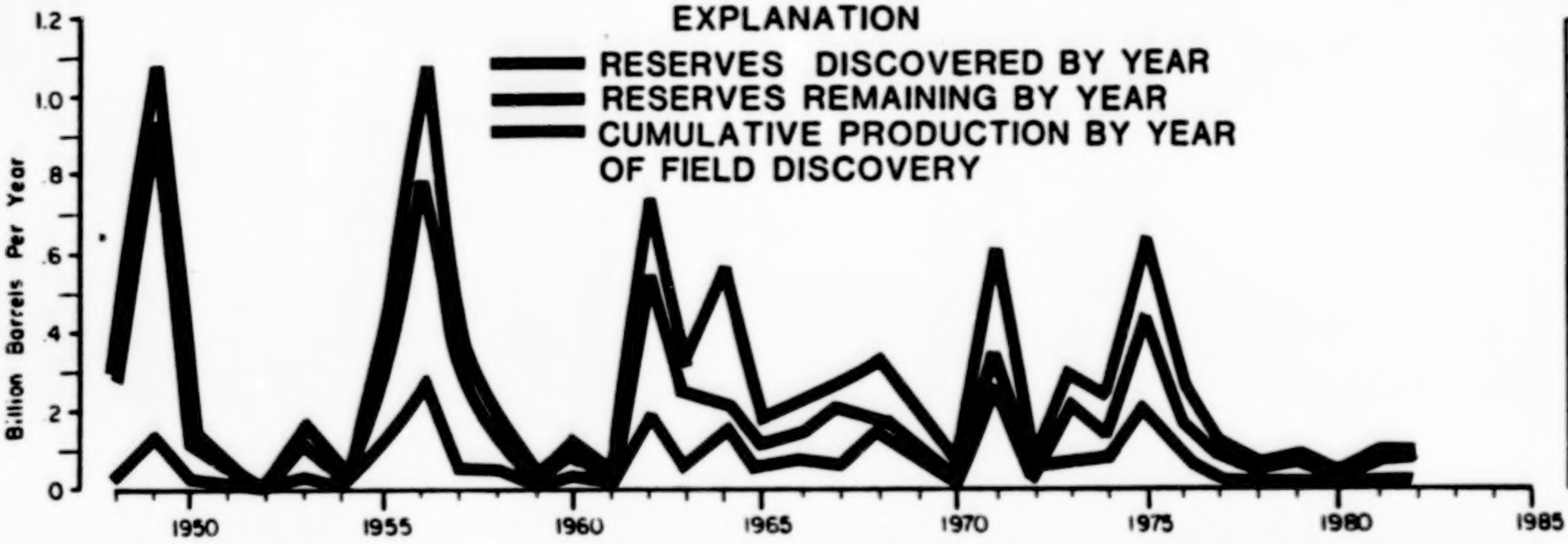

FIGURE 6 --OIL RESERVES AND PRODUCTION BY DISCOVERY YEAR

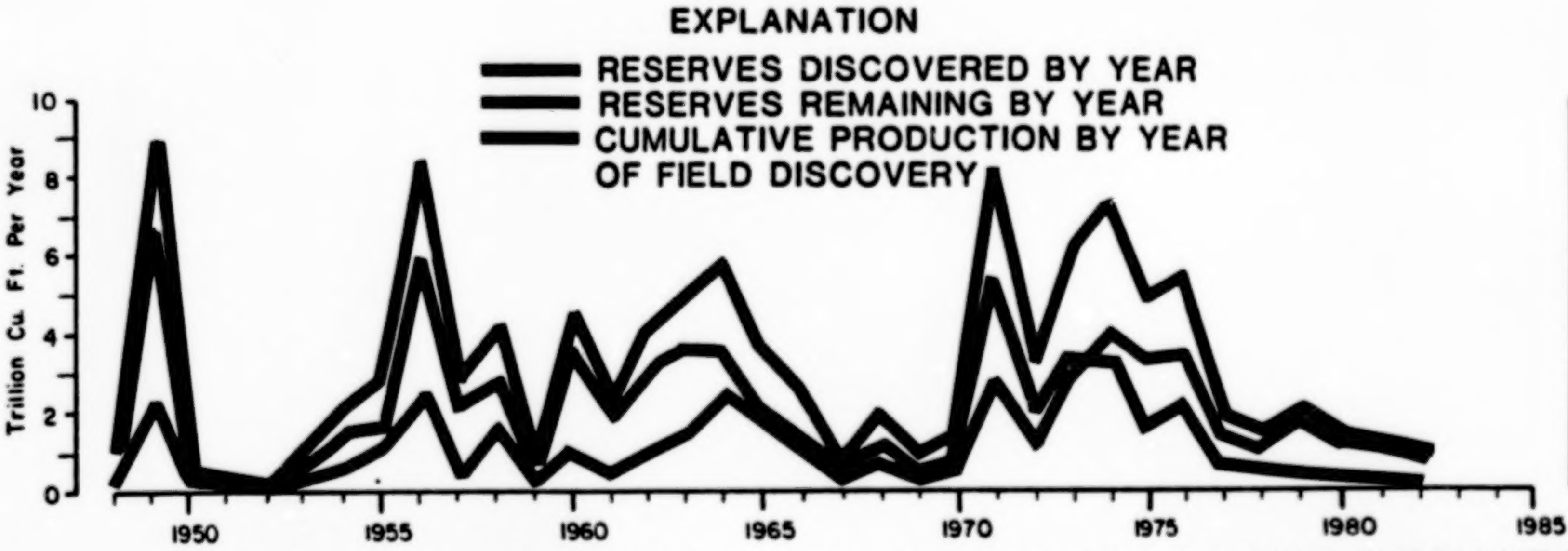

FIGURE 7 -- GAS RESERVES AND PRODUCTION BY DISCOVERY YEAR

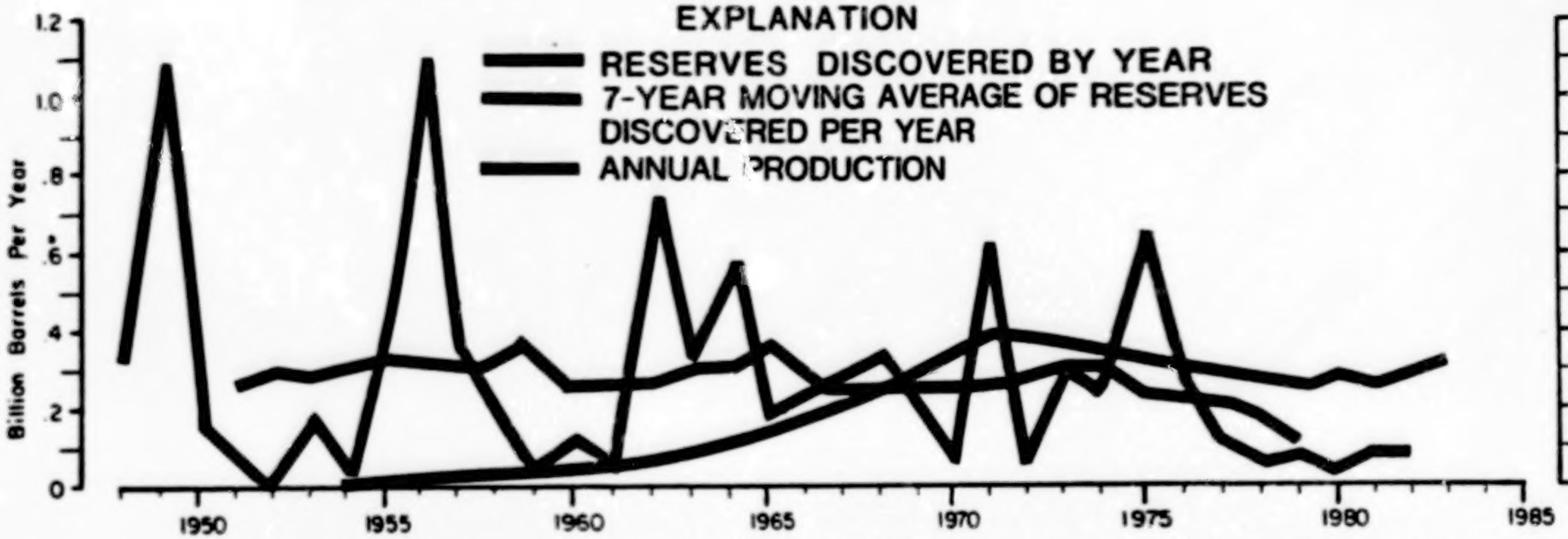

FIGURE 8--OIL RESERVES DISCOVERED AND OIL PRODUCTION

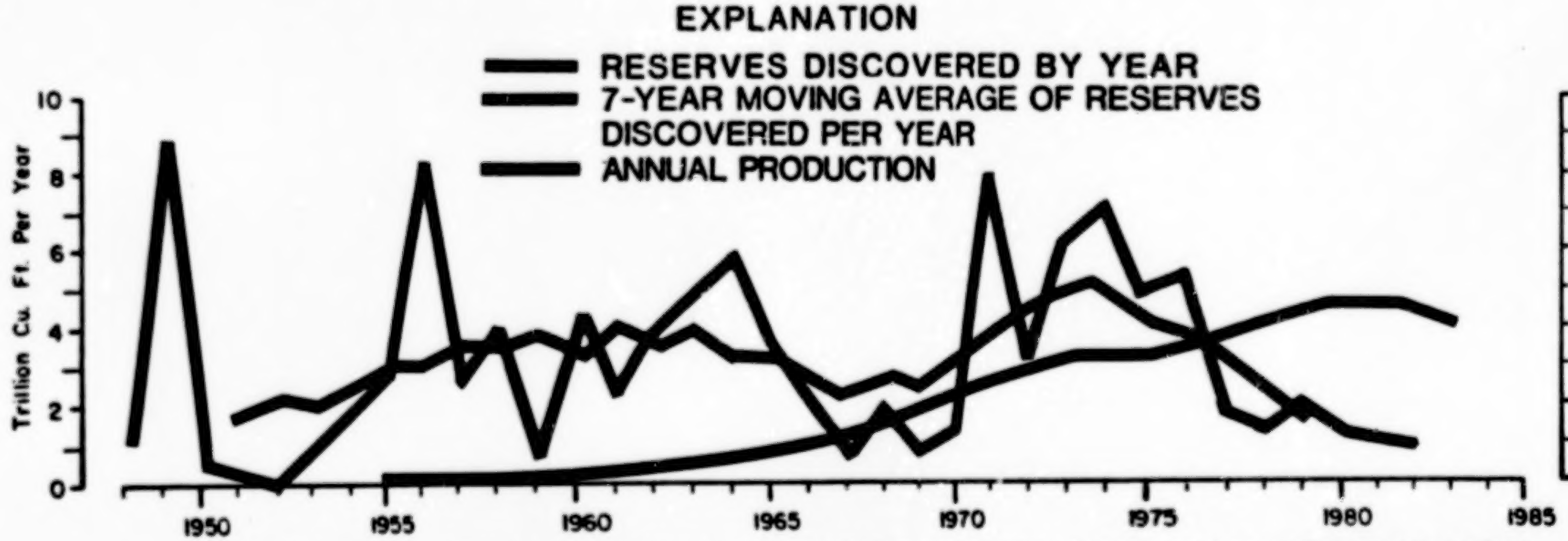

FIGURE 9-- GAS RESERVES DISCOVERED AND GAS PRODUCTION

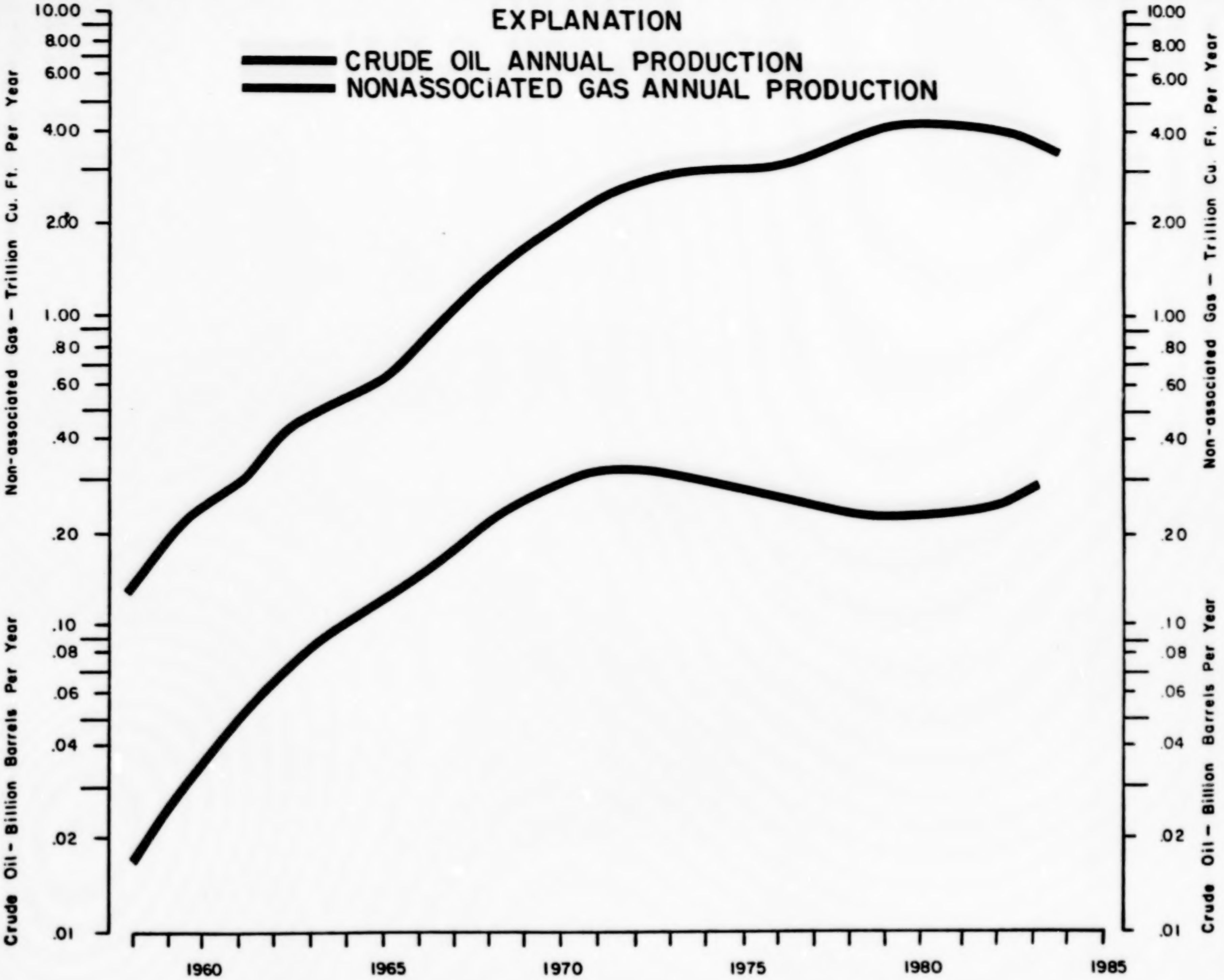

Figure 10— Crude Oil And Nonassociated Gas Production

discoveries every year since 1967. The annual gas production (fig. 9) exceeded the 7-year moving average of gas discoveries for the first time in 1977.

All data presented in figures 6 and 8 include crude oil and condensate, and all data presented in figures 7 and 9 include associated and nonassociated gas.

Annual production of crude oil and nonassociated gas (gas-well gas) is shown in figure 10, with production volumes plotted on logarithmic scales. The crude oil production reached an annual peak of 0.32 billion barrels during the 1971-1972 period and then decreased. In the last four years oil production has increased. The 1980 production was only a slight increase over the previous year, but the 1982 and 1983 increases were significant. The annual crude oil production in 1983 was the highest production since 1974. However, the annual nonassociated gas production continues to decrease, establishing the 1981 production of 4.5 trillion cubic feet as the highest annual nonassociated gas production to date.

SUMMARY

A summary of reserve estimate changes during the year and comparisons with the estimates as of December 31, 1982, are shown in table 4. The increase of original recoverable reserves resulting from new field discoveries (6 oil fields and 37 gas fields) is summarized and tabulated as changes to original recoverable reserves. Reserve estimates are revised as warranted, increasing reserves as additional wells are drilled and new leases are added to existing fields and decreasing reserves as reservoirs are depleted and leases are relinquished. Complete reevaluations of existing field studies are conducted as field development and production history indicate the need. These increases and decreases of reserve figures are summarized and presented as changes due to revisions.

Table 4.--Summary and comparison of oil and gas reserves as of December 31, 1982, and December 31, 1983

	Oil (billion bbl)		Gas (trillion cu ft)	
Original recoverable reserves:				
Previous est., as of 12/31/82 (Hewitt and others, 1983)		8.56		98.1
Discoveries	+0.11		+1.7	
Revisions	+0.64		+6.3	
Adjustments	0.00		+0.1	
Net change		+0.75		+ 8.1
Estimate, as of 12/31/83 (this report)		9.31		106.2
Cumulative production:				
Through 1982 (Hewitt and others, 1983)		5.58		58.3
Adjustments		0.00		+ 0.1
Through 1982 (corrected)		5.58		58.4
Production during 1983 (preliminary)		+0.32		+ 4.1
Through 1983 (this report)		5.90		62.5
Remaining recoverable reserves:				
Previous est., as of 12/31/82 (Hewitt and others, 1983)		2.98		39.8
Discoveries	+0.11		+1.7	
Revisions	+0.64		+6.3	
Adjustments	0.00		0.0	
Production during 1983 (preliminary)	-0.32		-4.1	
Net change		+0.43		+ 3.9
Estimate, as of 12/31/83 (this report)		3.41		43.7

Owing to the approximations in the production and reserves as listed in table 1, partly caused by rounding field data to two significant figures and subsequent correction of lease production reports, adjustments to cumulative production totals may be necessary in reconciling balances between annual reports. These adjustments are also shown in table 4.

Table 4 demonstrates that the 1983 oil discoveries and field revisions exceeded oil production by 0.43 billion barrels of oil and the 1983 gas discoveries and field revisions exceeded gas production by 3.9 trillion cubic feet.

CONCLUSIONS

The 521 oil and gas fields studied in the federally regulated part of the Gulf of Mexico originally contained reserves estimated at 9.31 billion barrels of oil and 106.2 trillion cubic feet of gas. Remaining recoverable reserves, as of December 31, 1983, are estimated to be 3.41 billion barrels of oil and 43.7 trillion cubic feet of gas. These figures represent an increase in estimated oil and gas reserves.

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